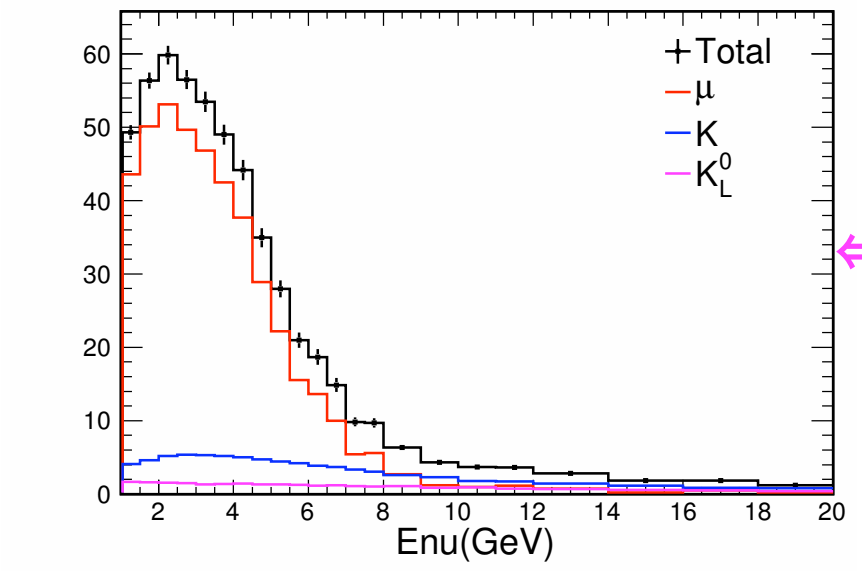
Length of the Decay Pipe in LBNE

- Background to ν_e
  - NuMI has a 675m long, R=1m decay pipe
  - But ~250m (R=2m) for LBNE?

- Concerns for a longer (~400m) decay pipe
  - High-Ev ⇢ Low-Ehad NC
  - What is NC cross-section
  - π^0's in NC
  - Cost

ν_e LE010z185i flux

νe in NuMI

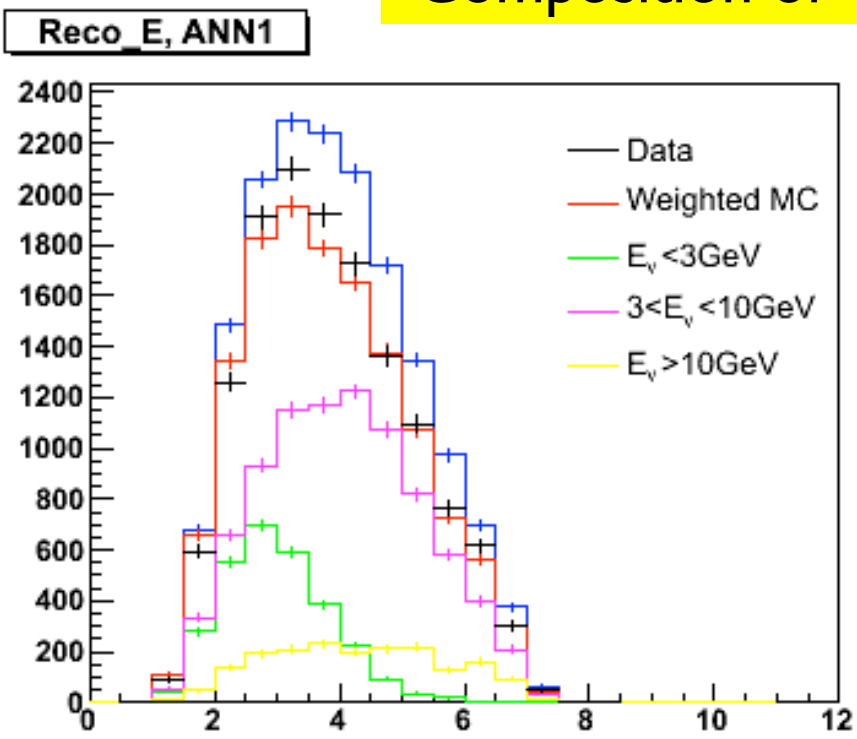


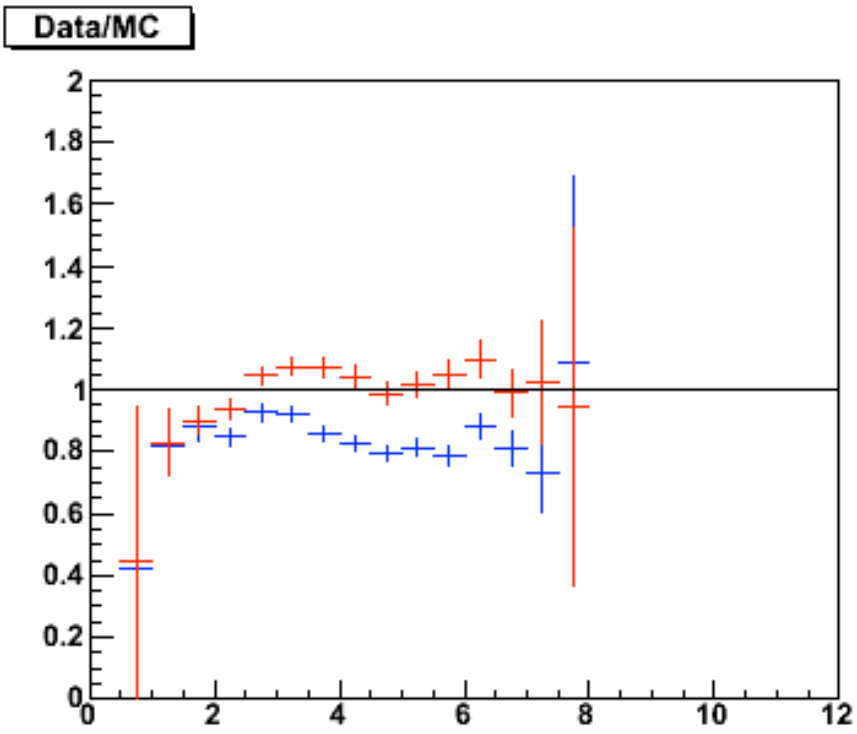
⇐ νe/νμ Prediction using the fitted EP-Flux to ND

Figure 2: The EP-predicted composition of ν_e

- μ → νe will be determined to very high accuracy using νμ-CC
- In νe-appearance, the μ-background cannot be a concern.

Composition of `NC' in MINOS-ND





- Long Enu-tail
- These are mostly NC-events

➢ Enu>10 GeV contribution to the NC-Pi0 background is small

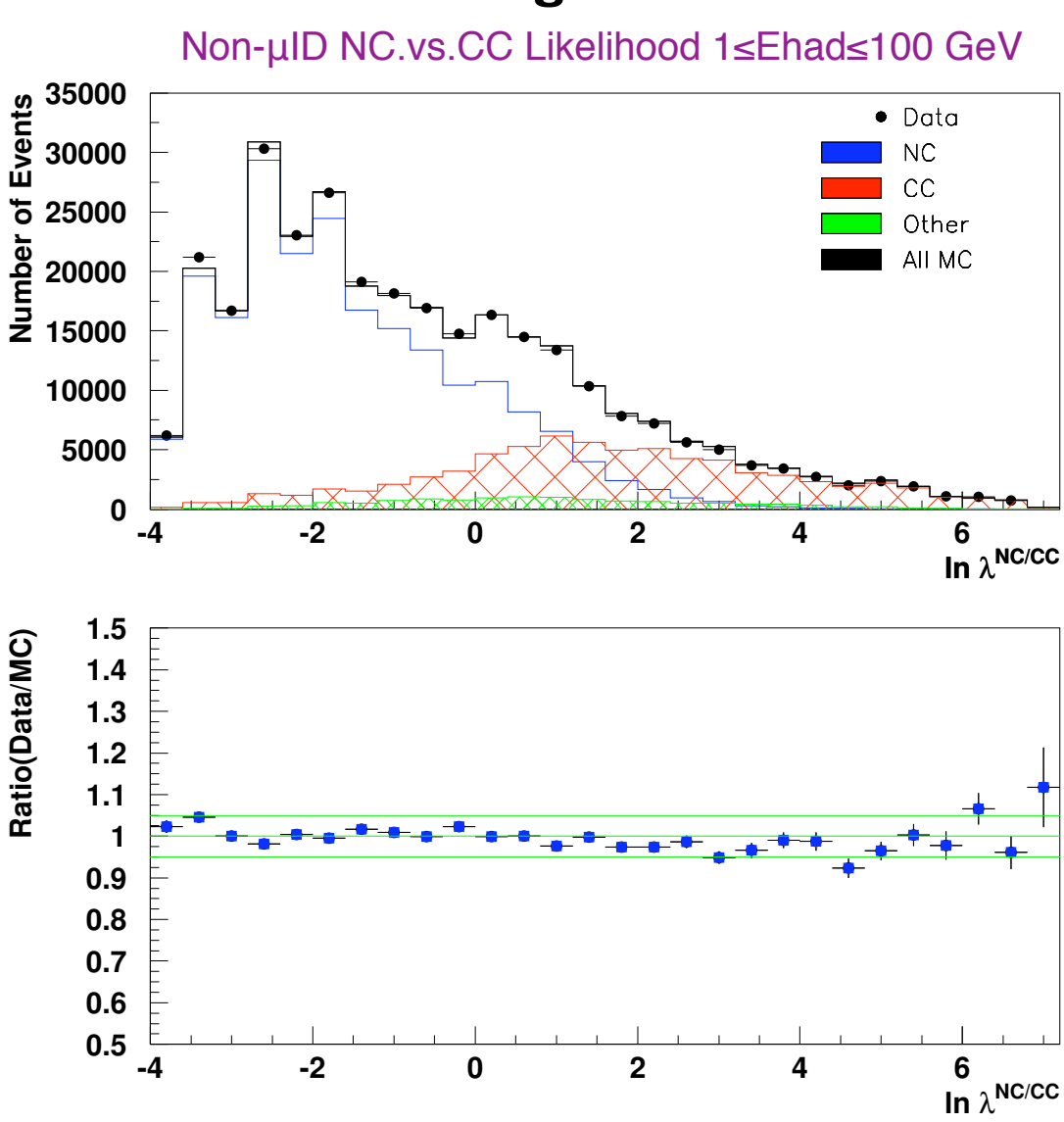
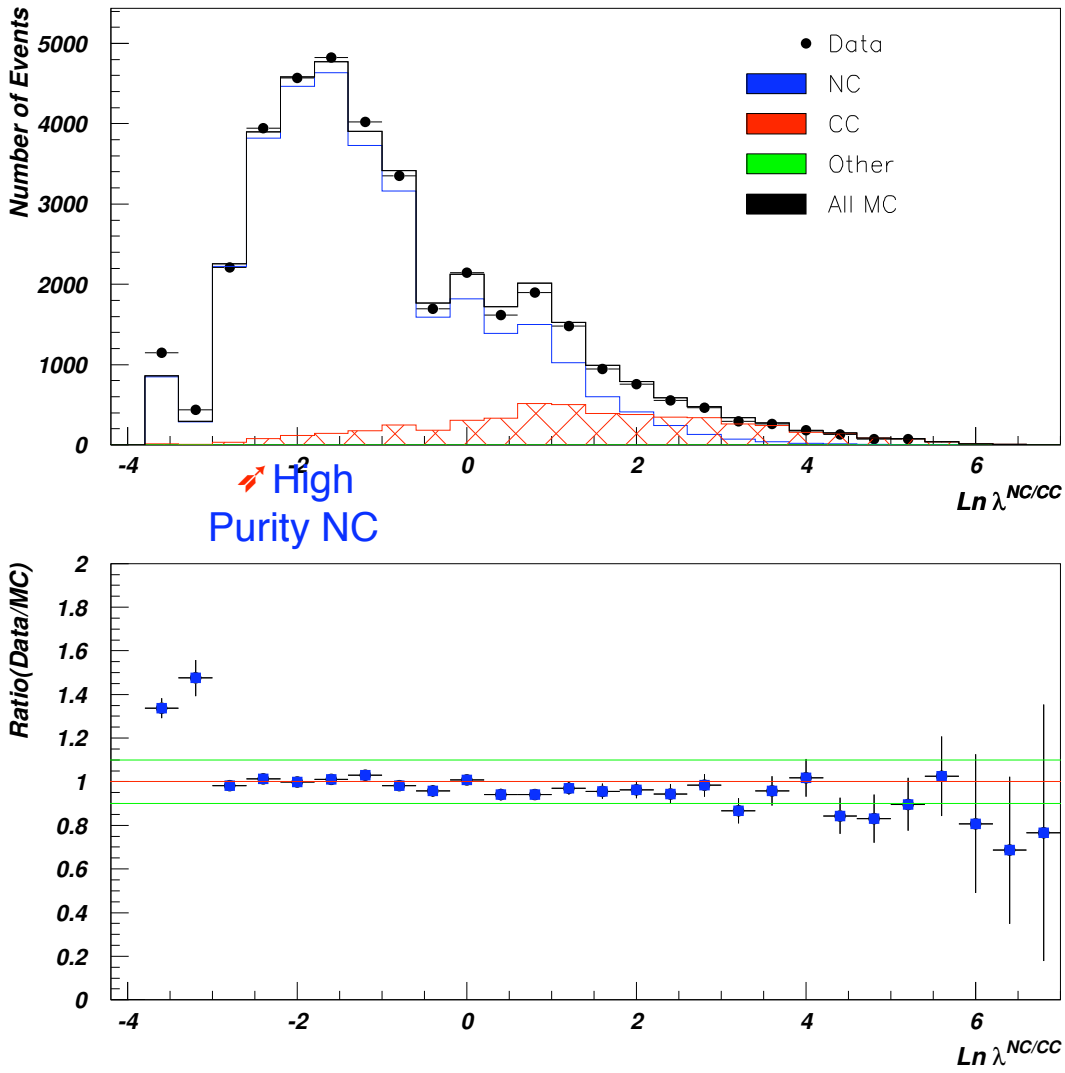
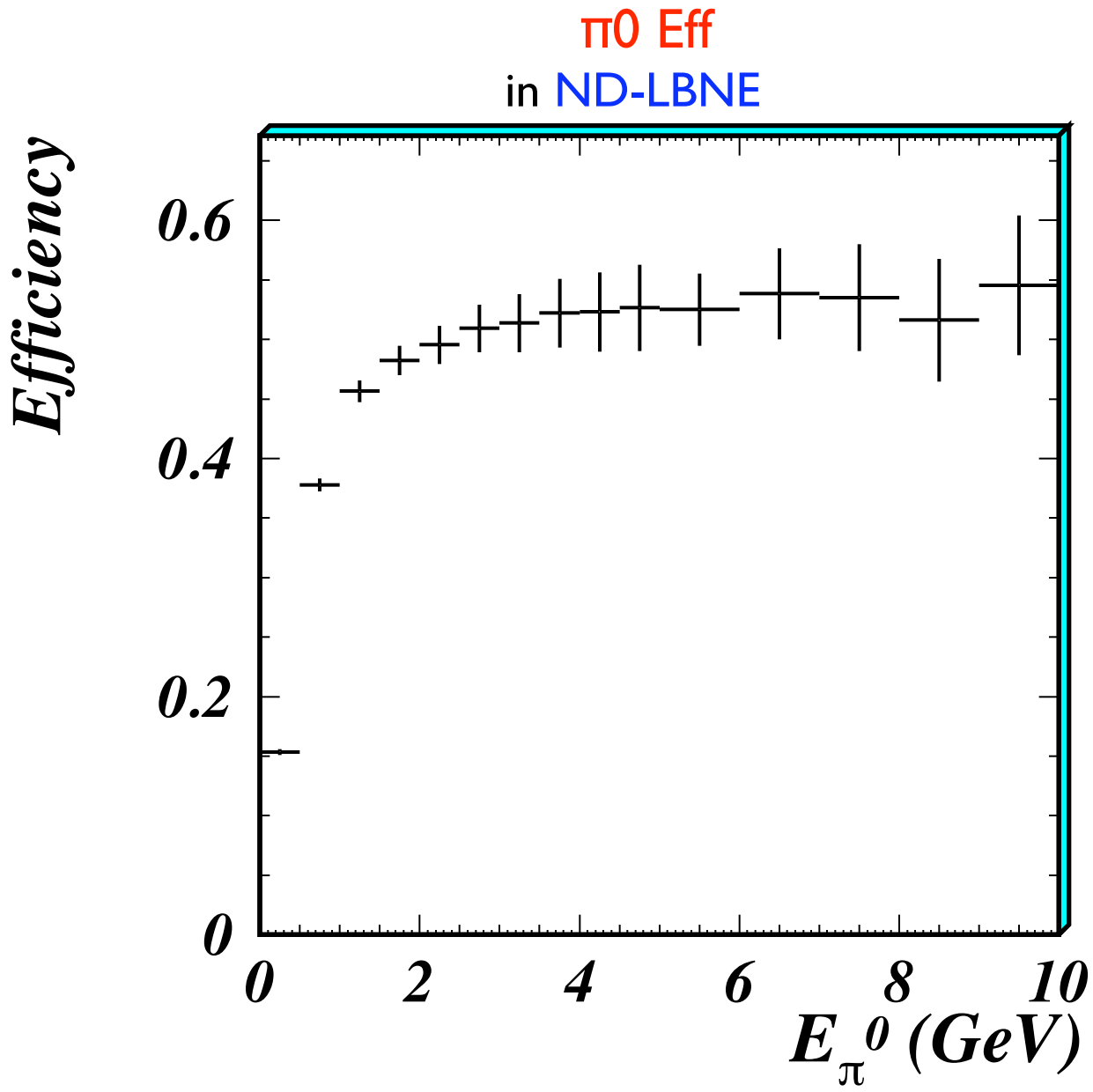


Figure 4: The Neutral Current versus Charge Current $\ln \lambda^{NC/CC}$ for the Non-μID Events: Shown are the $\ln \lambda^{NC/CC}$ distributions of data (Symbol) and the Monte Carlo. The MC is composed of the NC from all ν's (Blue), the ν_μ-CC (hatched-Red), and the 'rest' induced by $\overline{\nu}_\mu$, ν_e, and $\overline{\nu}_e$ CC interactions (fine-hatched Green). The ratio of Data/MC, bracketed by $\pm 5\%$ band (Green), is shown below.

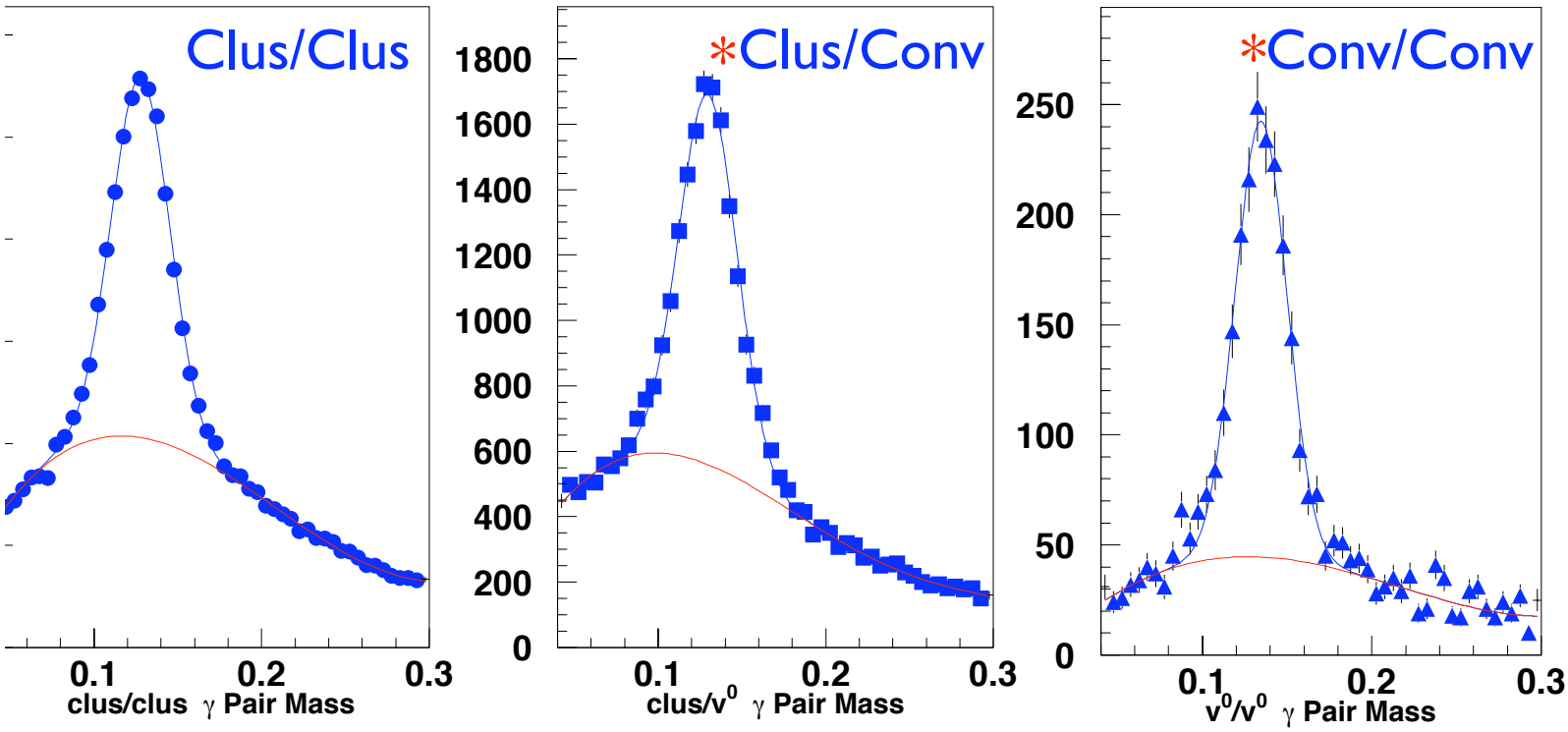


NC/CC will be determined to a very precision in ND-LBNE

Figure 22: The Neutral Current versus Charge Current Likelihood of "non-MuID" events in $\mathbf{1 \leq E_{Had} \leq 5}$ GeV: Shown are the $\boldsymbol{ln\lambda^{NC}}$ distributions of data (Symbol) and Monte Carlo composed of the NC (Blue), the CC (hatched-Red), and the 'rest' (fine-hatched Green) induced by $\overline{\boldsymbol{\nu}}_{\boldsymbol{\mu}}$, $\boldsymbol{\nu_e}$, and $\overline{\boldsymbol{\nu}}_{\boldsymbol{e}}$ interactions. The ratio of Data/MC bracketed by $\pm$**10**% band (Green) is shown below.


π0 Eff
in ND-LBNE
Efficiency
0.6
0.4
0.2
0
0
2
4
6
8
10
E_{π^0} (GeV)

Reconstructed π^0 in NC interactions in NOMAD



Overall more than 33k reconstructed events. Three topologies:

- *Cluster/Cluster 24k events*
- *Cluster/Conversion 7k events*
- *Conversion/Conversion 2k events*

[HiResMnu: expect similar resolution and much lower combinatorics]

✺ Low-Ehad NC events induced by High-Enu do not control the NuE-appearance sensitivity
(e.g. NC-Pi0 with Evis=3 GeV, induced by e.g. Enu=20 GeV, will not pass the NuE-selection)

✺ LBNE will have a much more precise handle on NC-Cross-section, NC-Pi0, and Mu/K⇝NuE than NuMI

✺ Having a decay pipe with, say, L~400m, allows the FD an unprecedented statistical precision in 10<Enu<50 GeV --- a region not at all explored for Oscillation-Physics in any experiment with high precision

✺ With well understood background and flux, the high Enu-region offers a unique opportunity to make discoveries

✺ L~400m allows for better precision measurement and searches in the ND

Cost

Consider L=400m, R=1.5m (Loose ~12-15% of flux at 2nd. Max compared to R=2m; little loss at 1st.Max)

Vol(New)/Vol(Old) ~ 0.9

My Inclination: (L=400m, R=1.5m) is preferable to (250m, 2m) --- the default choice

We are designing a facility which will last for 20 years

- An appeal not to cast into stone the length of the decay pipe to be 250m which will compromise the overall physics potential of LBNE program